

# Attribution Concepts for Sub-meter Resolution Ground Physics Models

**76<sup>th</sup> MORS Symposium  
US Coast Guard Academy**

**Approved for public release distribution.**

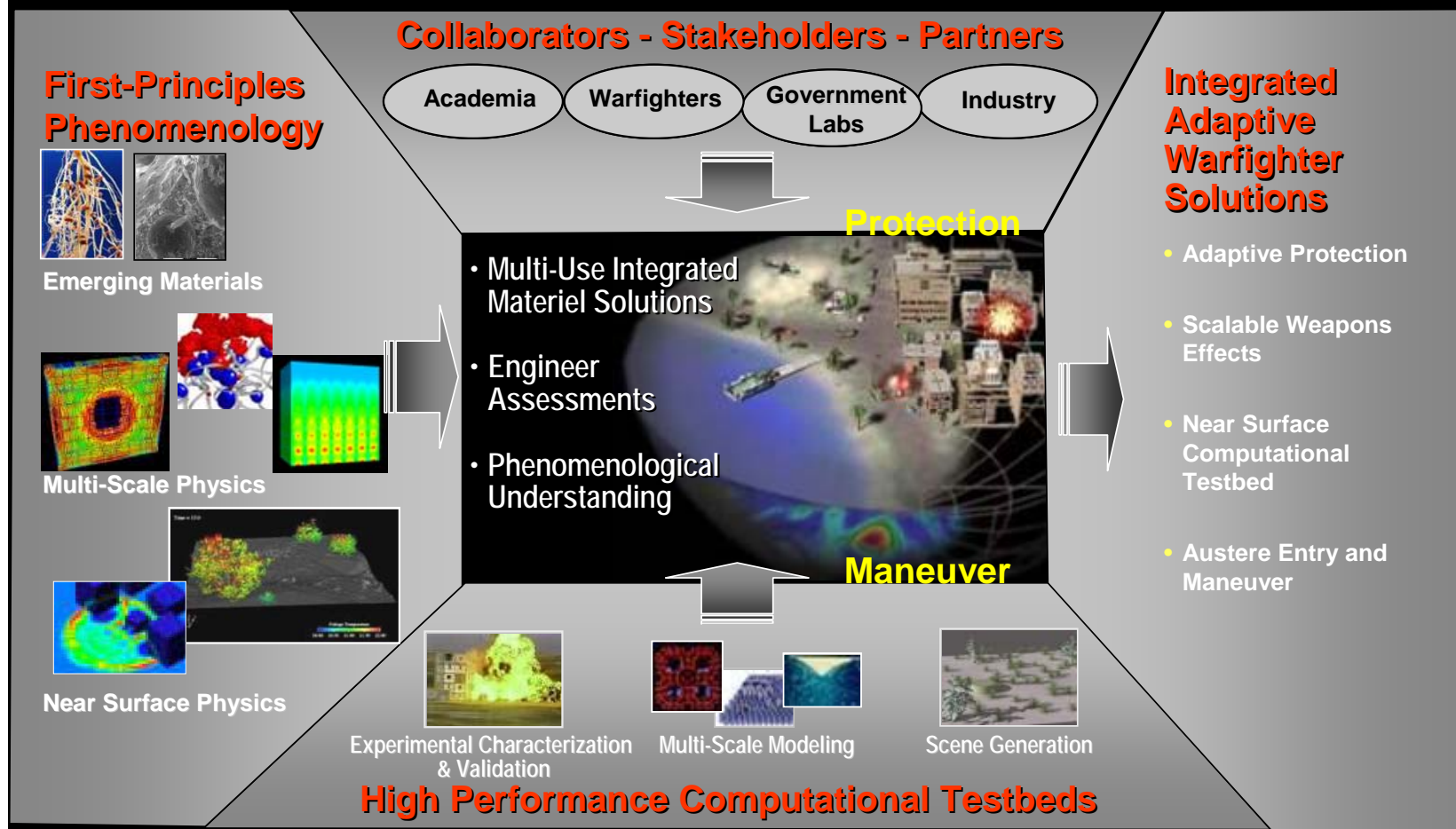
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# Focus for ERDC R&D In Military Engineering



## Adaptive Maneuver and Protection

*Developing Solutions Faster Than The Threat Can Adapt*



# Virtual Autonomous Navigation Environment (VANE)



## Scene Generation Models

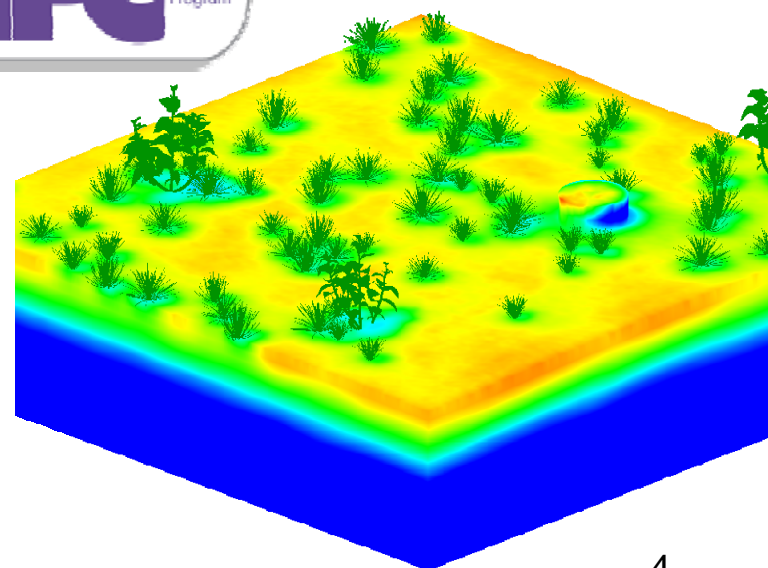
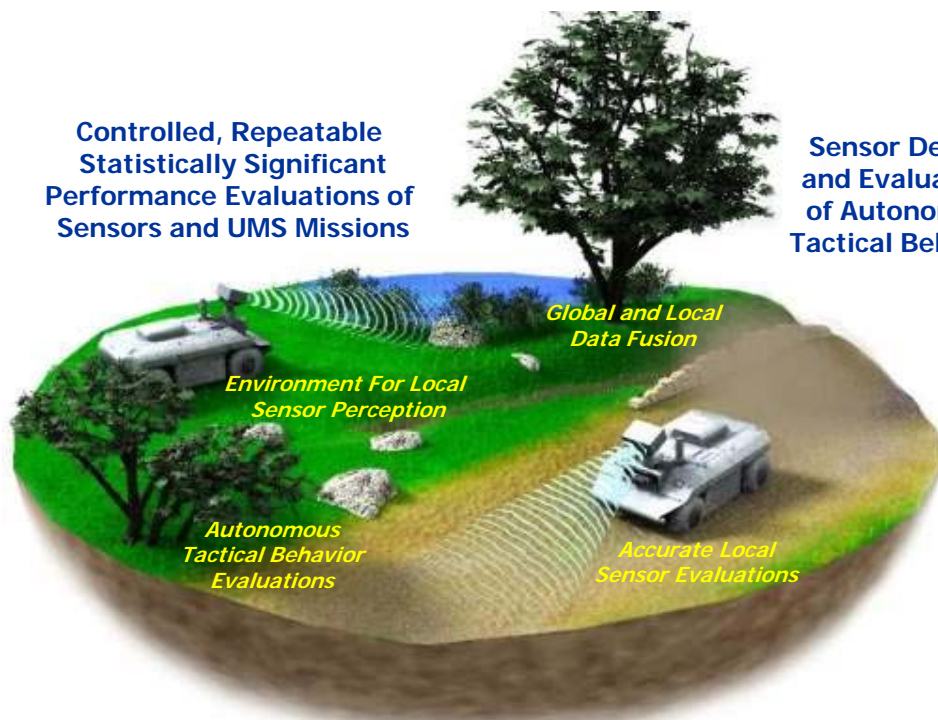
Colors, Stereo Images,  
Geology, Vegetation,  
Material Databases

## Component Models

Vehicle Dynamics,  
Sensor,  
Power Requirements

Controlled, Repeatable  
Statistically Significant  
Performance Evaluations of  
Sensors and UMS Missions

Sensor Designs  
and Evaluations  
of Autonomous  
Tactical Behaviors



## Vegetation Models

Thermal, Geometry,  
Reflectivity, Ray Casting

## Soil Models

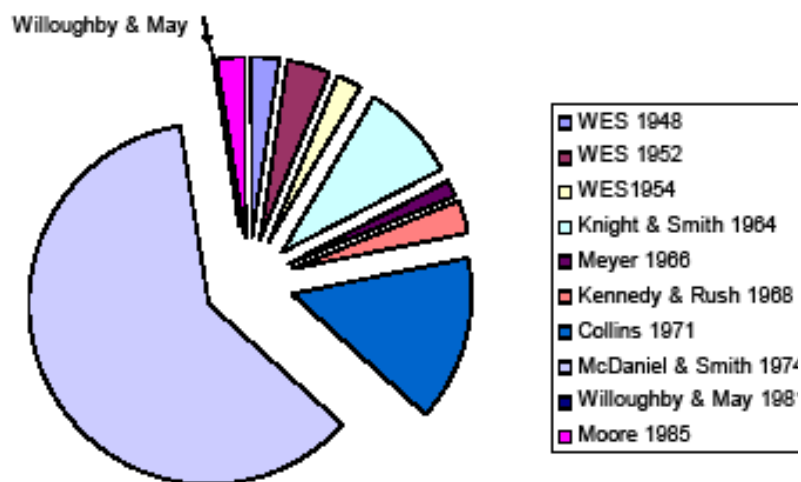
Strengths, Moistures,  
Thermal, Electromagnetics



# Global Databases Supporting Geospatial Attribution



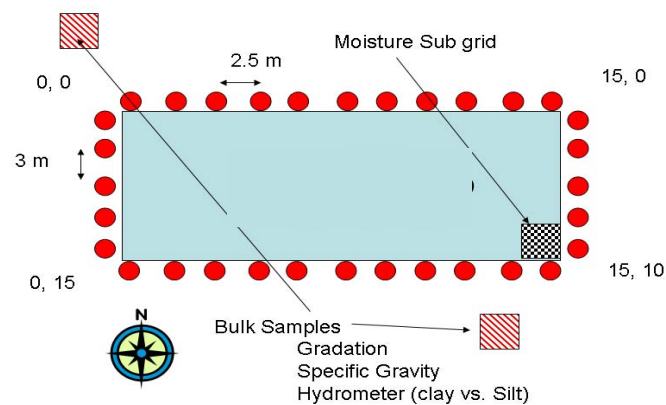
Historic Soils Dataset TR-08-2  
14000 Records From 10 TR's  
Physical Properties of Soils,  
Location, Attribution Consistent  
with CTB Inputs



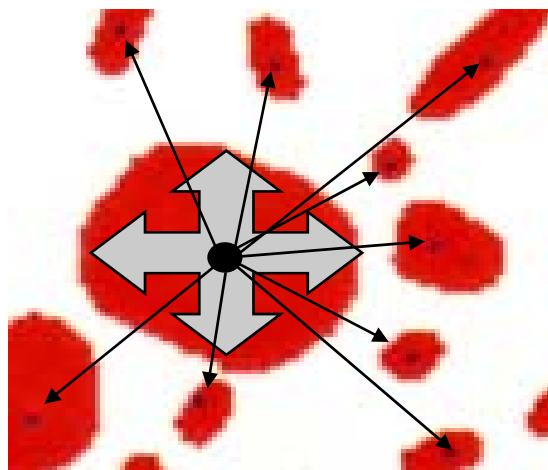
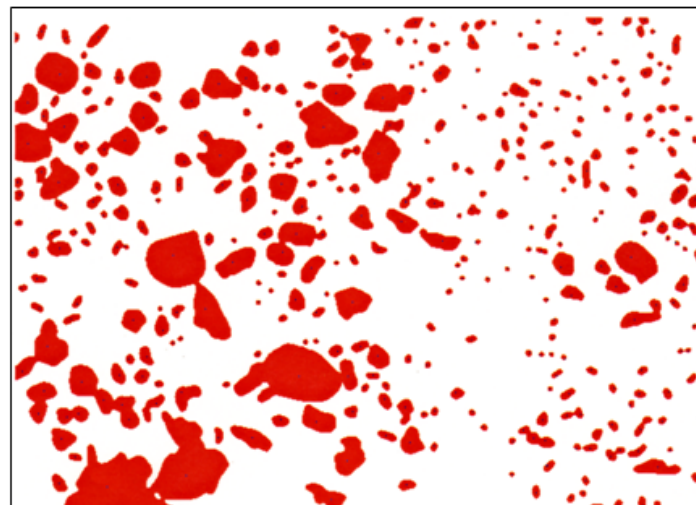
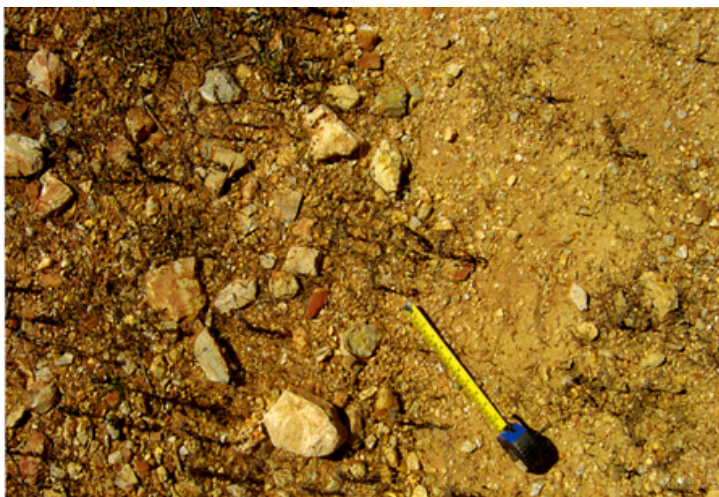
# Geostatistical Data Needs



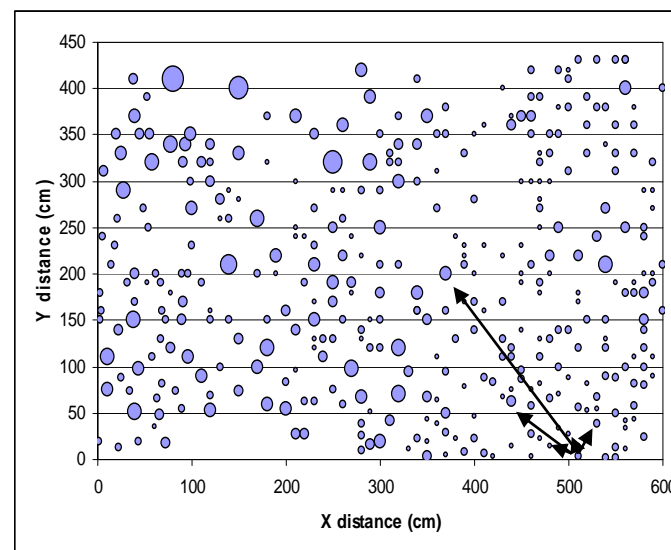
- How to Define Rocks within Strata
- Layering and Variance in Layers
- What are the Input Data correlations
- Correlations with Time and Distance



# Spatial Distribution of Rocks In Soil Mass

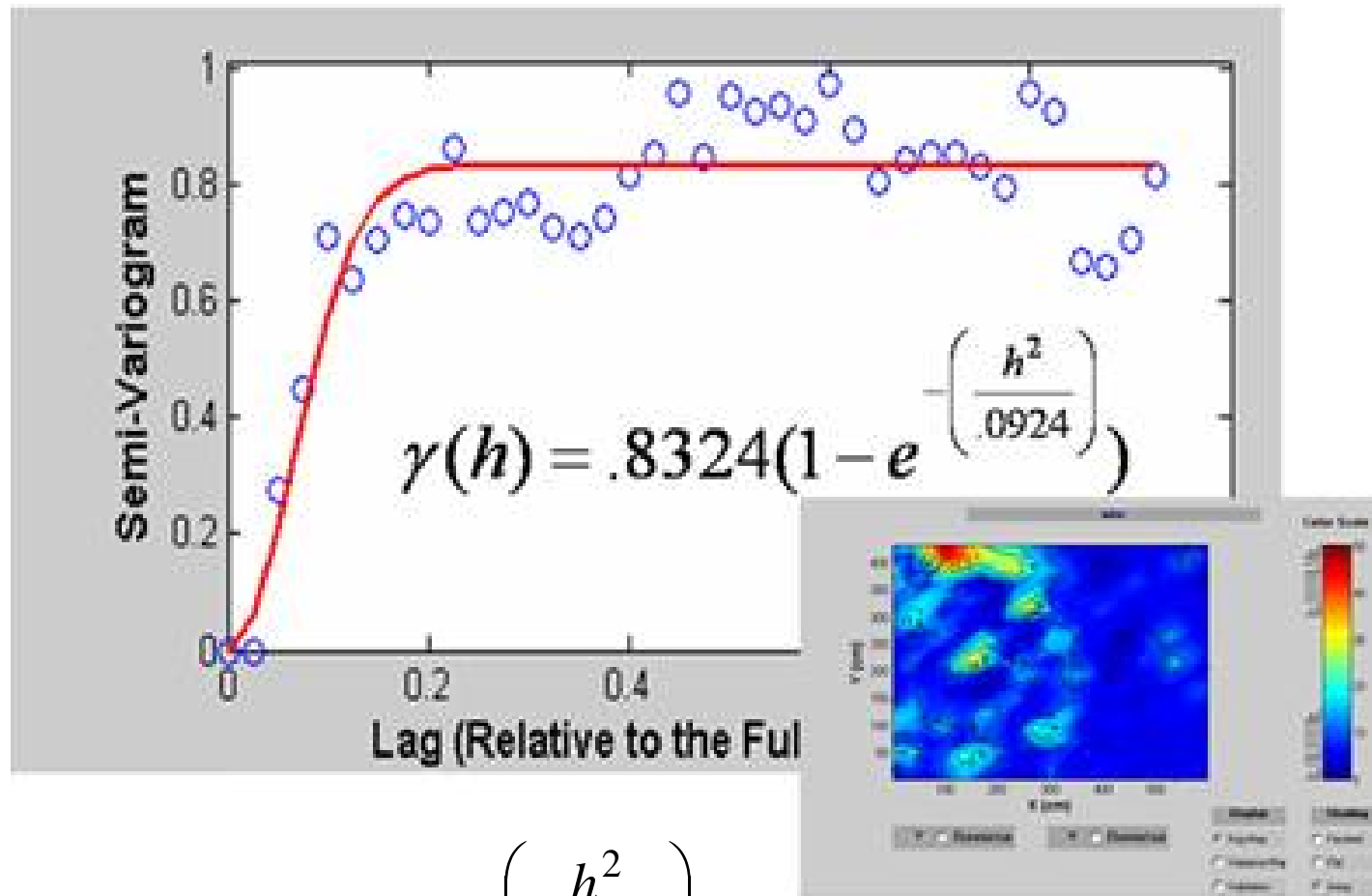


**Rocks are extracted and Highlighted in Red**





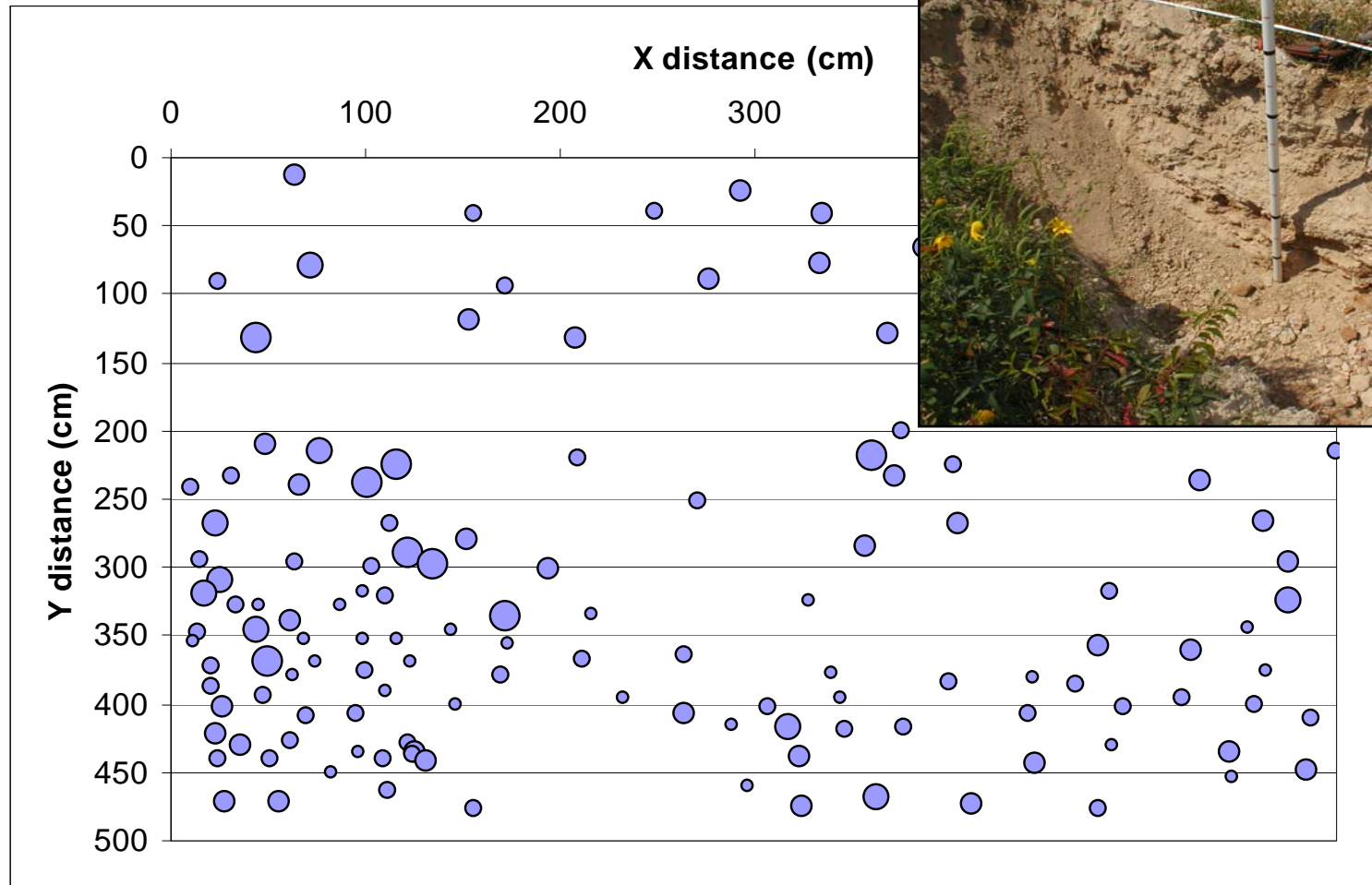
# Spatial Distribution of Rocks In Soil Mass



$$\gamma(h) = .8324(1 - e^{-\left(\frac{h^2}{.0924}\right)})$$



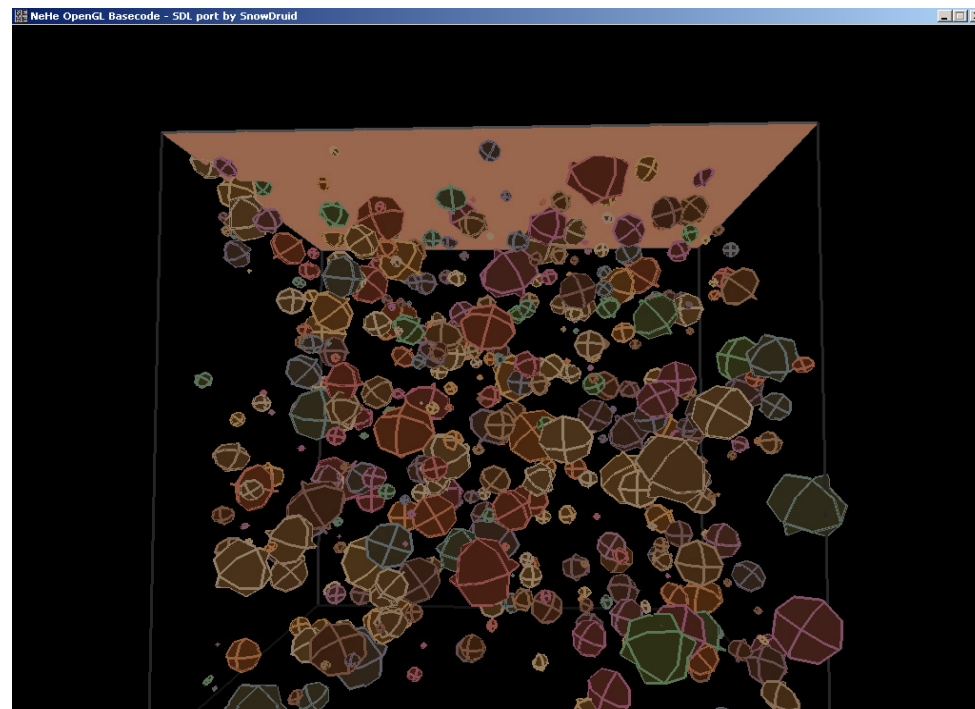
# Spatial Distribution of Rocks In Soil Mass



**Vertical Locations of Rocks Are Extracted in the Same Manner**

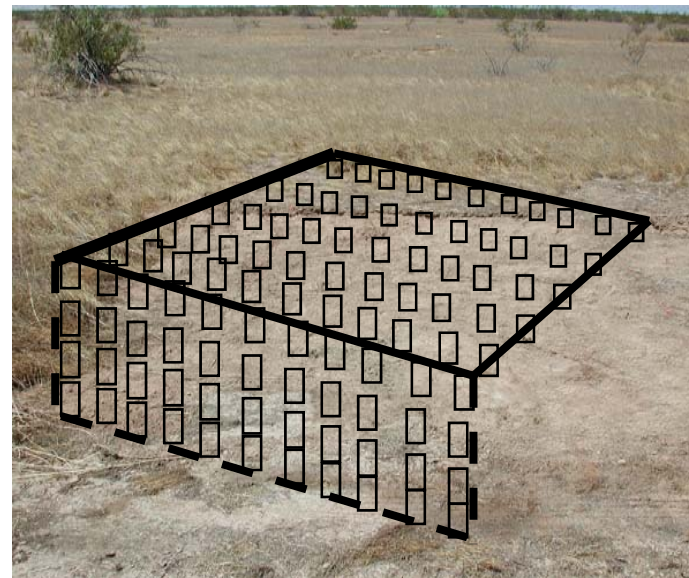
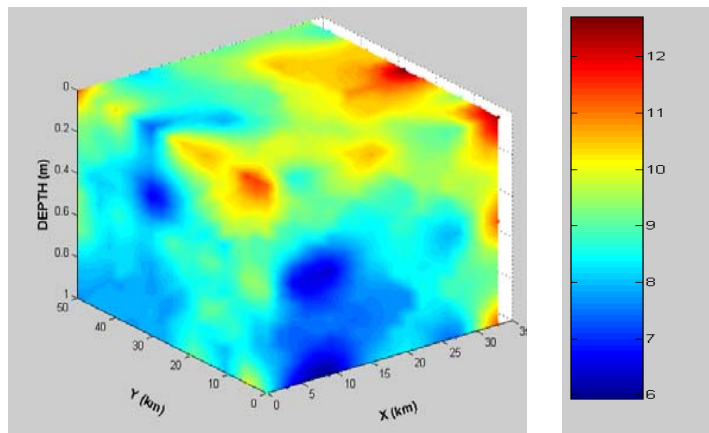
# Spatial Distribution of Rocks In Soil Mass

- **Program to define distribution from digital photographs**
  - **Number of Rocks**
  - **Size**
  - **Location**
  - **Orientation**

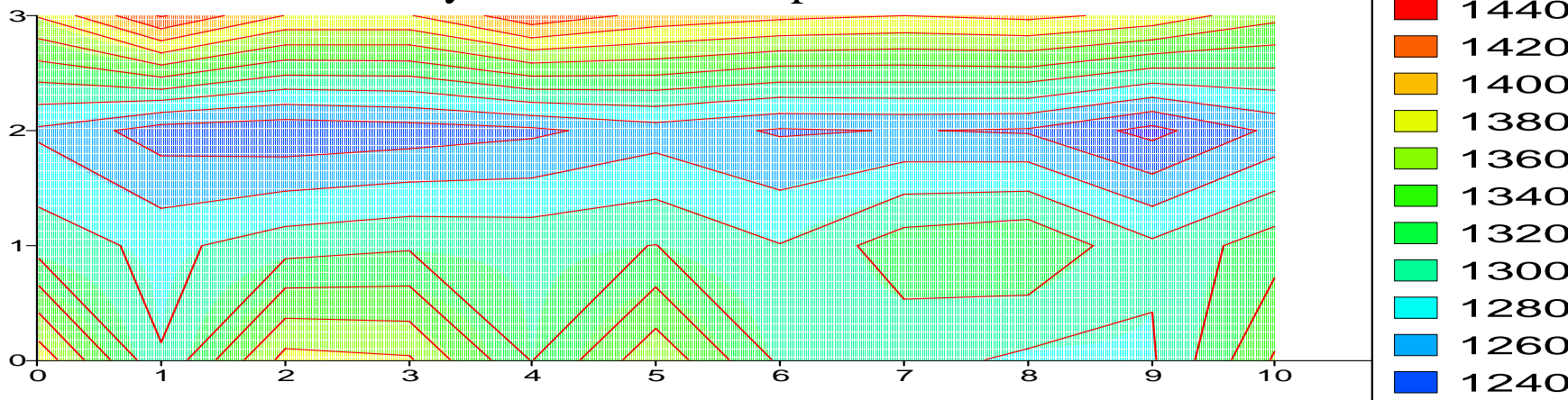


# Spatial Distribution of Moisture, Density, and Porosity in Soil Mass

Low Moisture indicates Changes  
whose Spatial Structure is Random

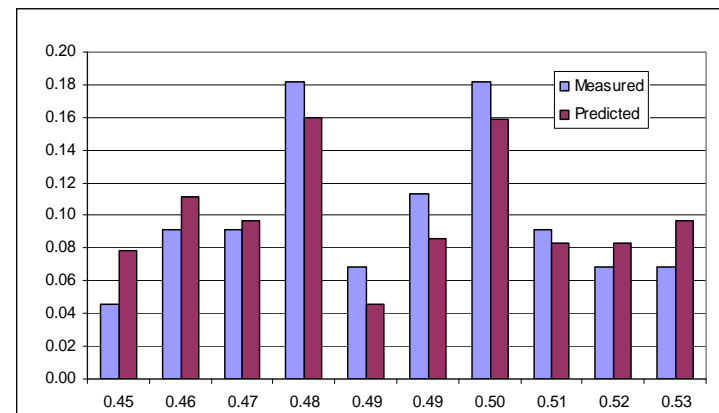
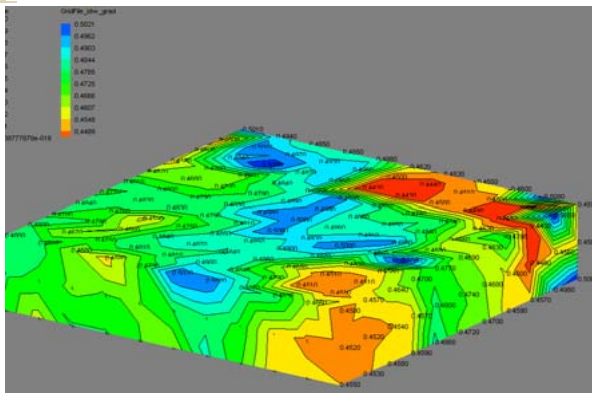


However Density Variations were predictable





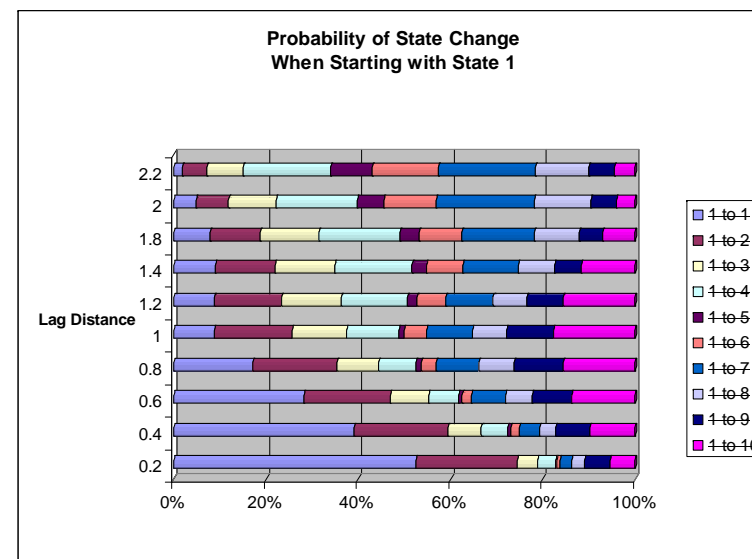
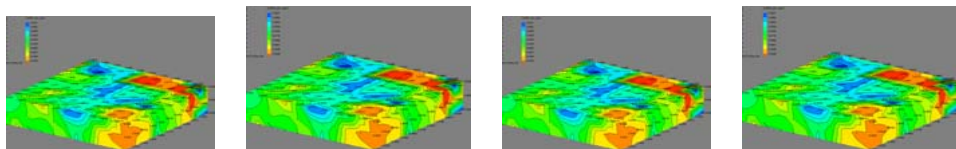
# High Resolution Data



Read Field Data  
Generate Matching SemiVariance and  
Frequency For High Resolution Grid

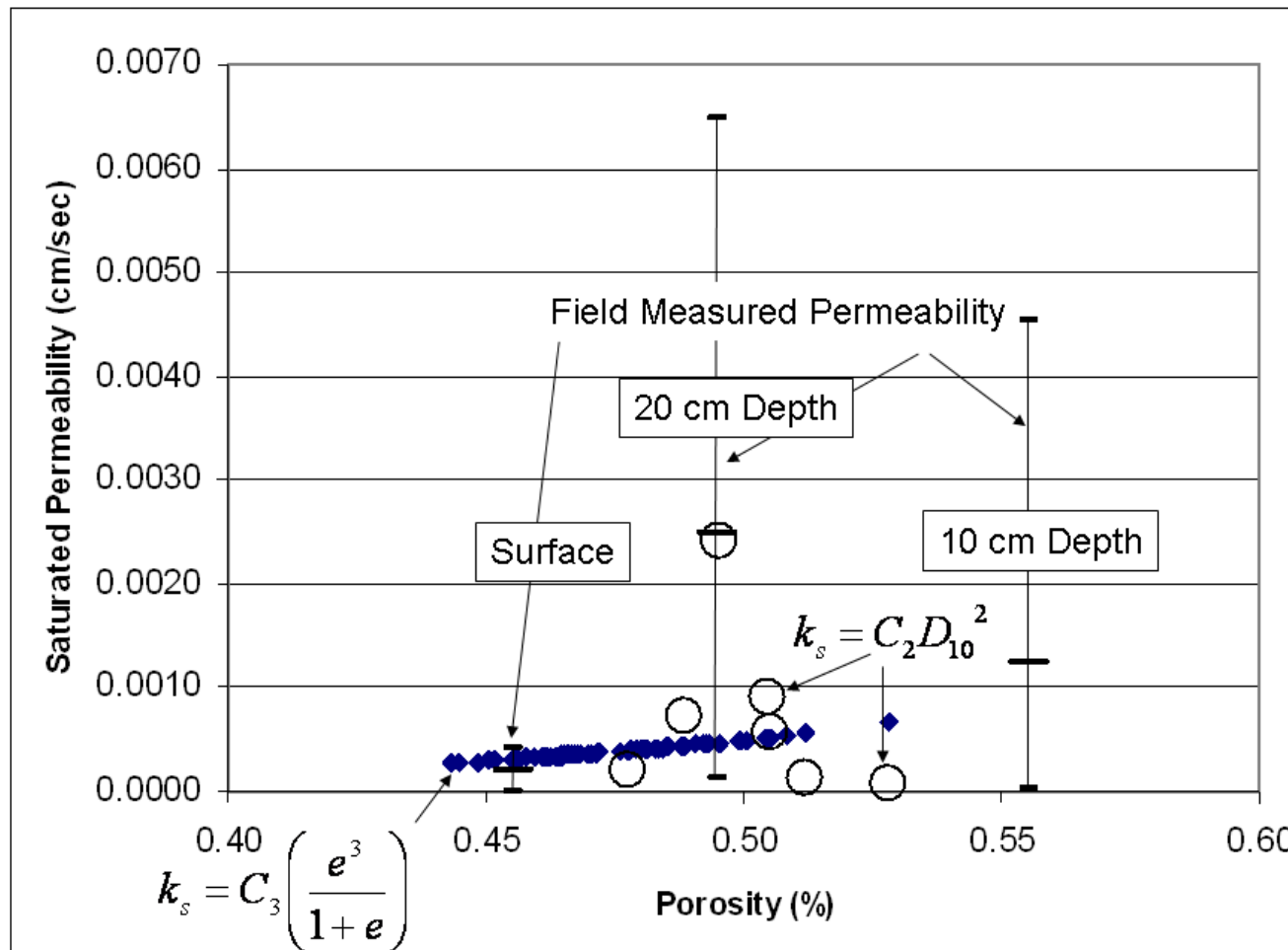
Create Transitional Probability Matrix

Generate Multiple Realizations

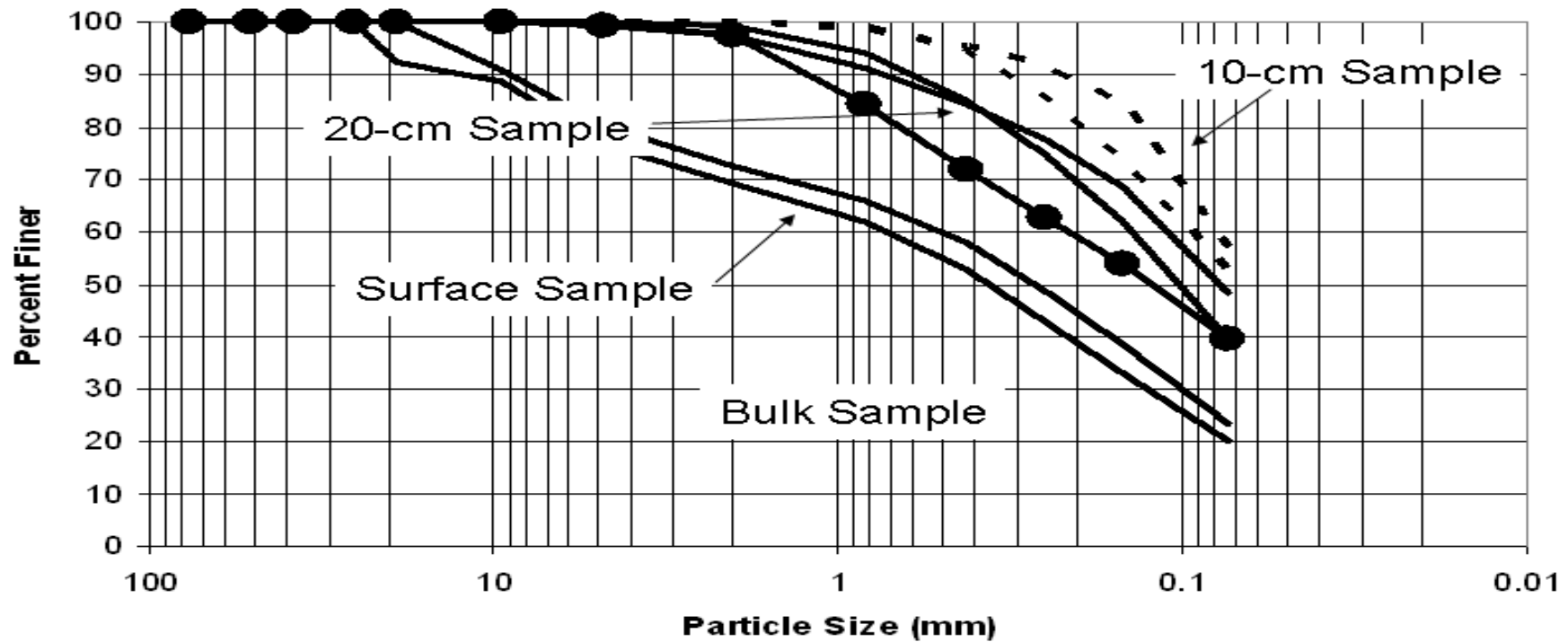
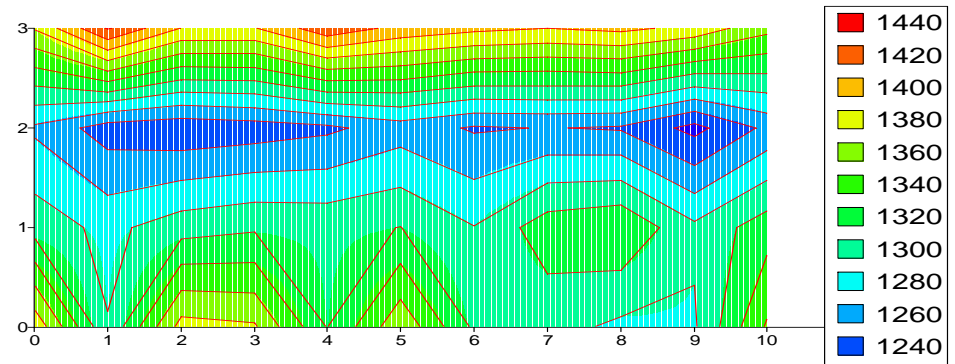
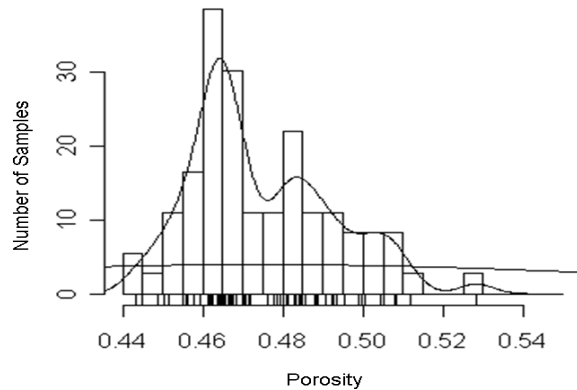




# Correlations for Missing Data



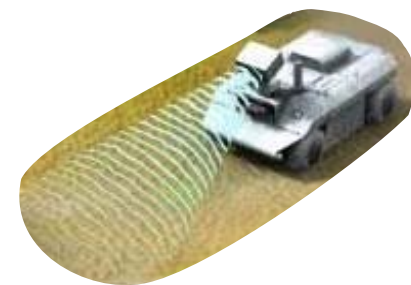
# Layering Effect in Density and Porosity



# Summary



- **ERDC research is now heavily focused on using high performance computing simulation testbeds**
- **Simulations like VANE involving sensor-terrain interaction will require relevant and realistically heterogeneous attributions for large scale, high resolution, numerical models**
  - **Techniques for characterizing spatial variability at multiple scales including sub-meter resolutions**
  - **Techniques for populating sparsely measured attributions using material attribute correlations to densely measured attributions**

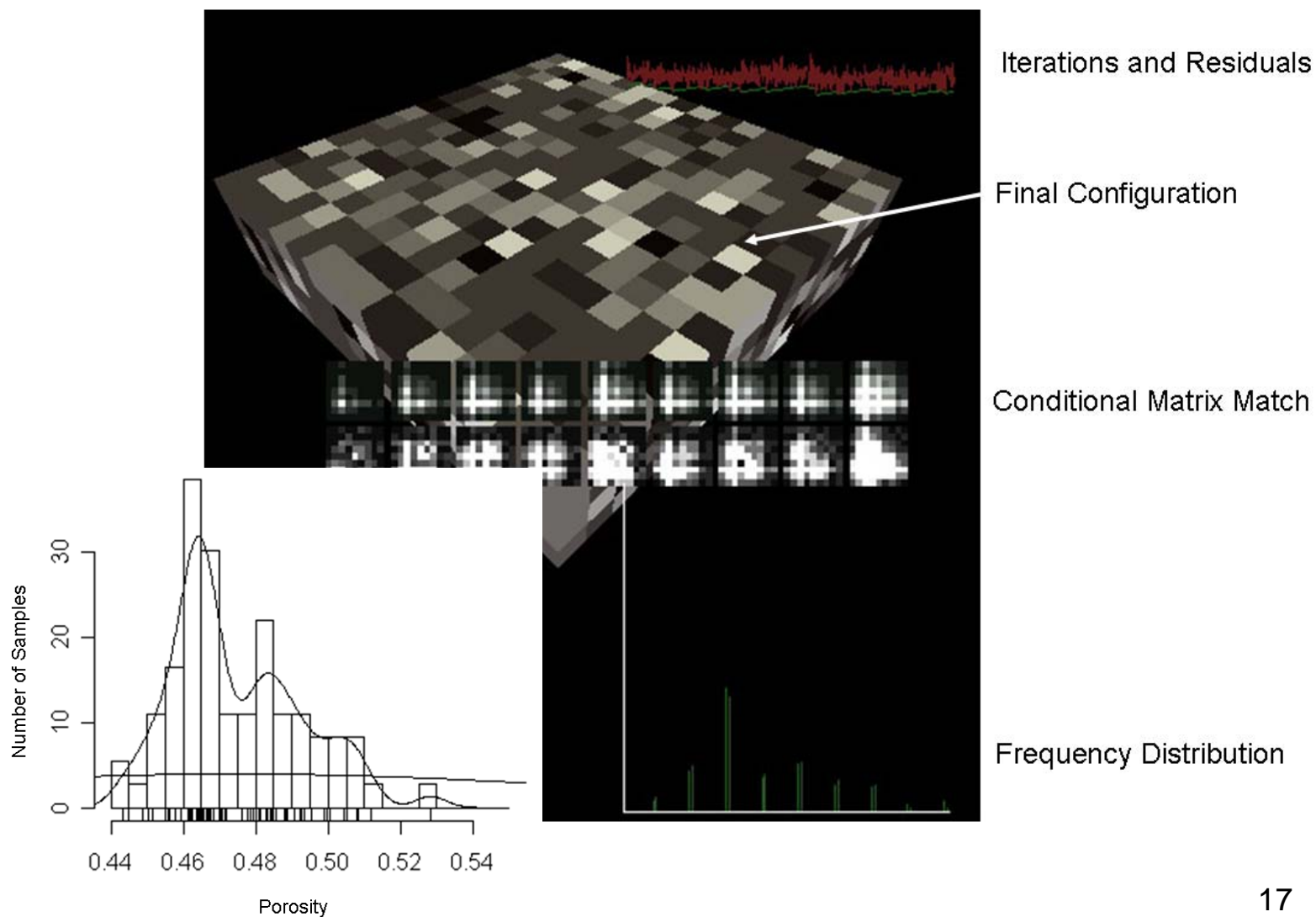


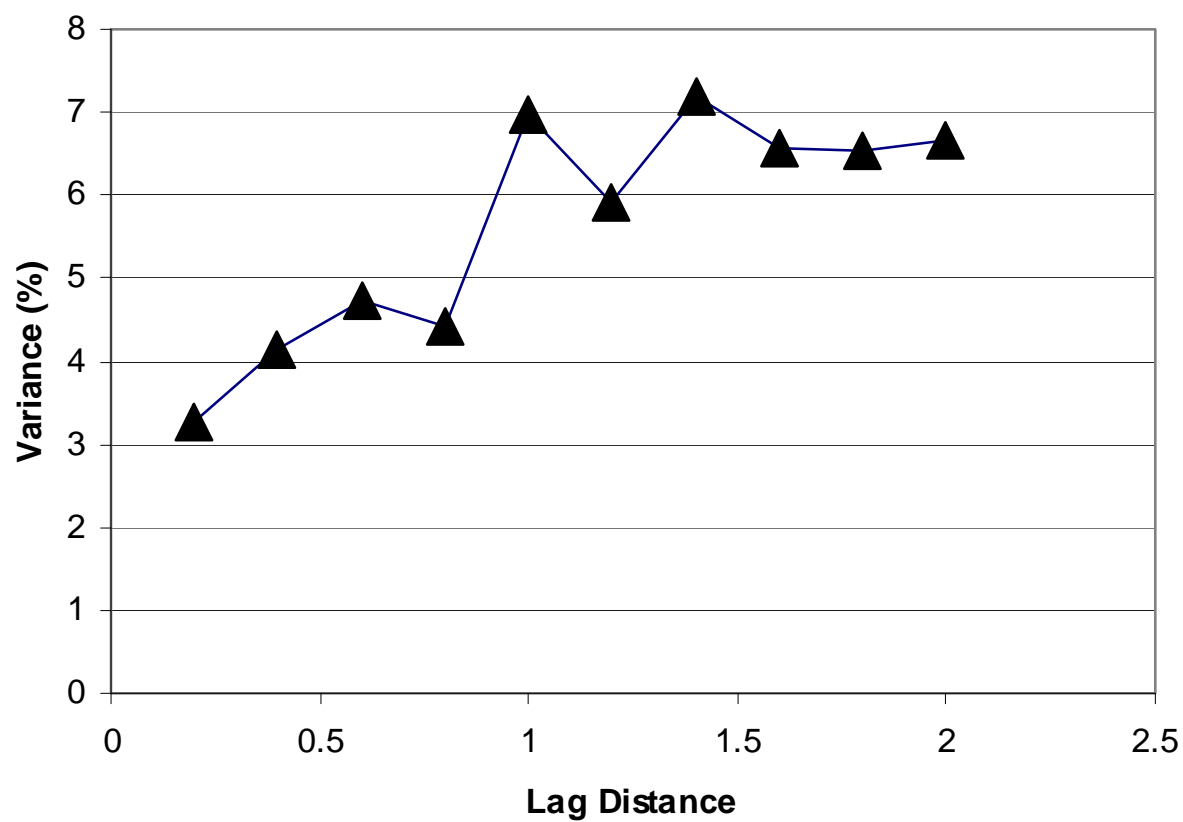


# BACKUP SLIDES



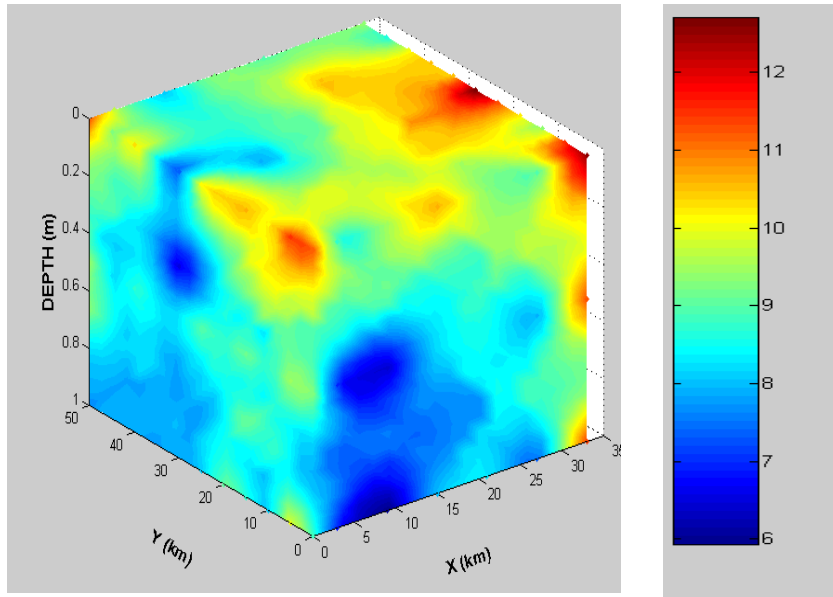




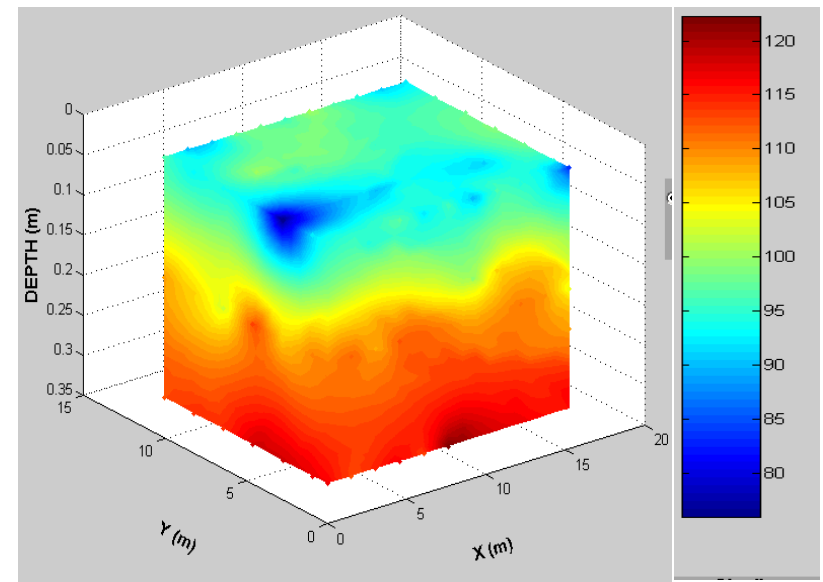


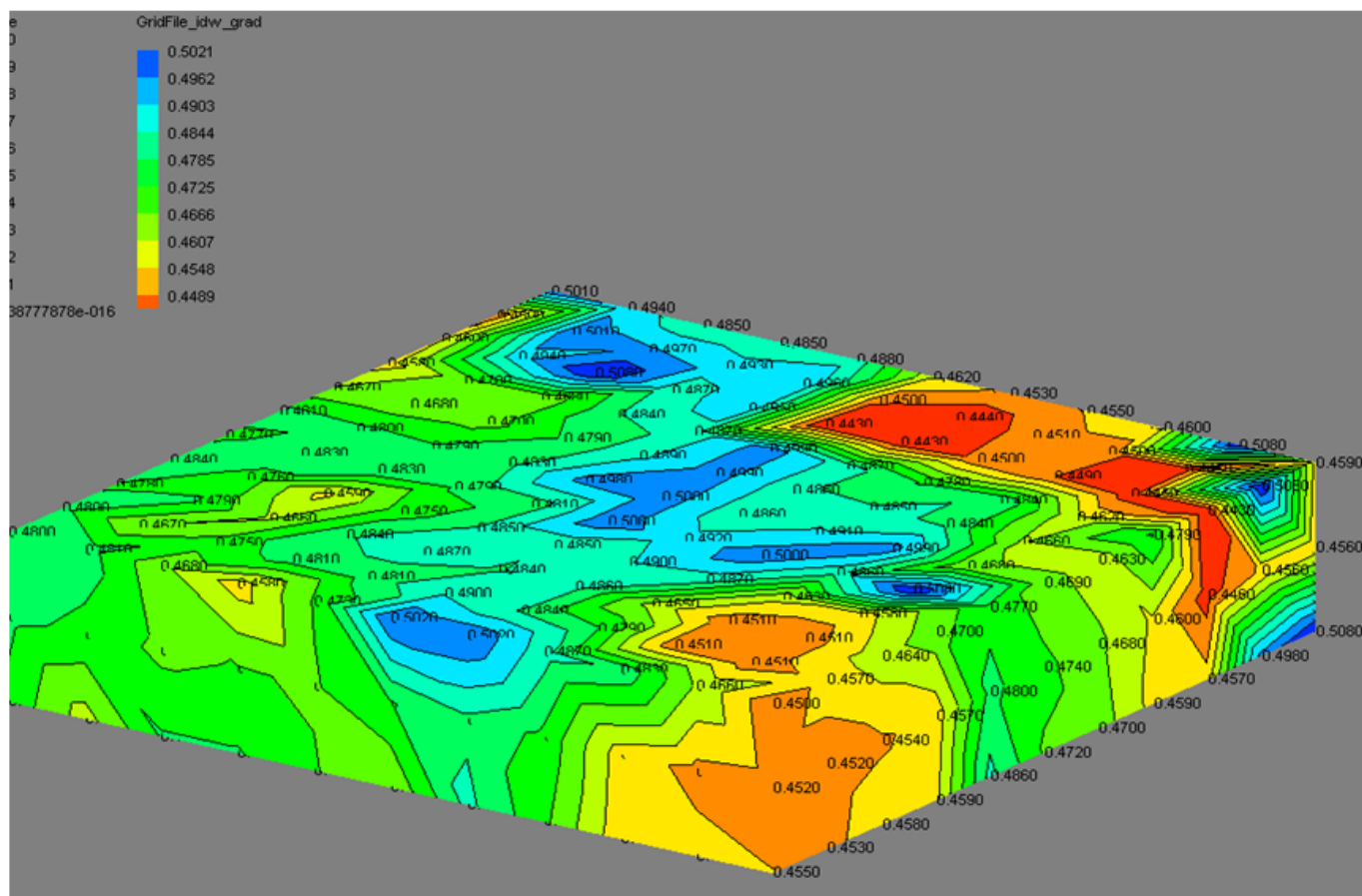
# The Generation of Moisture & Density for Subsurface Changes.

Low Moisture indicates Changes  
whose Spatial Structure is Random

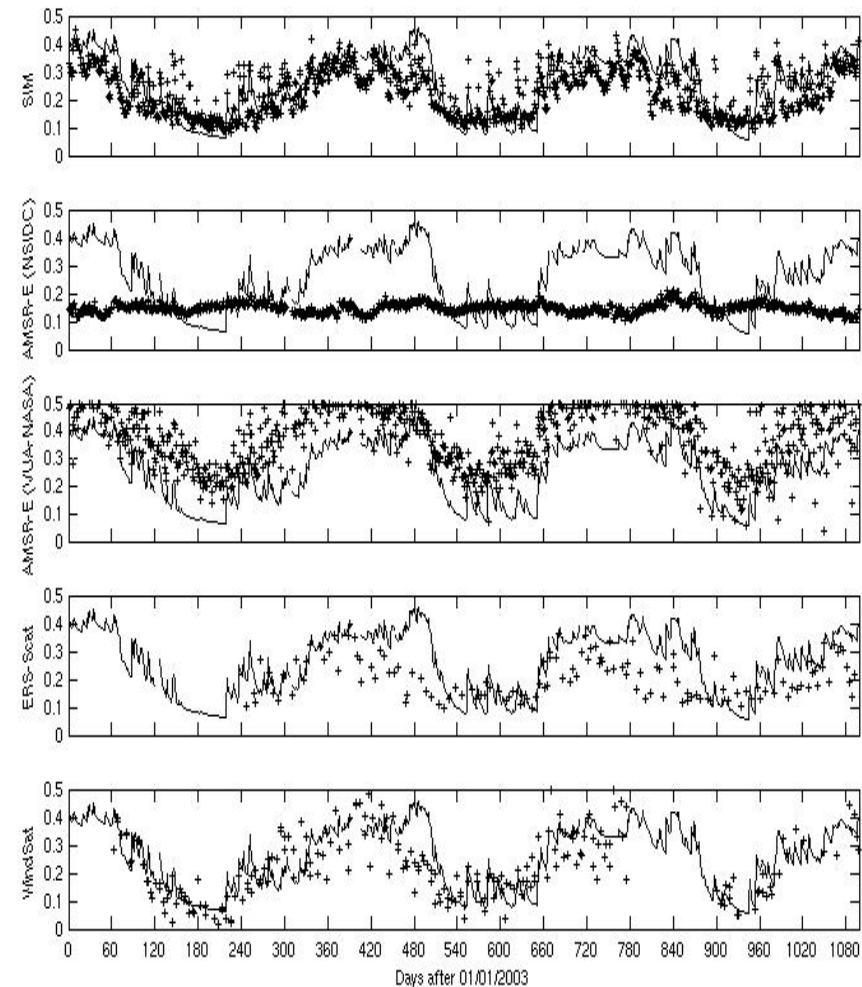
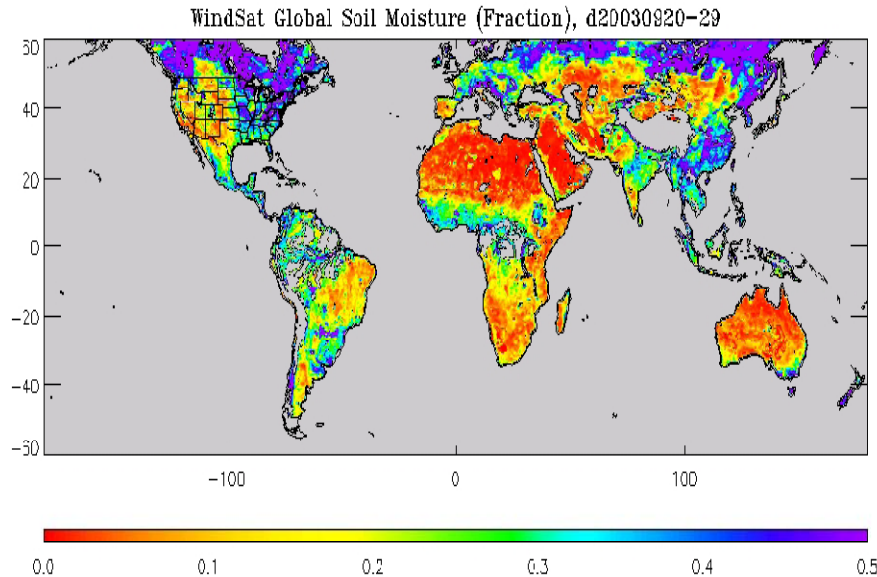
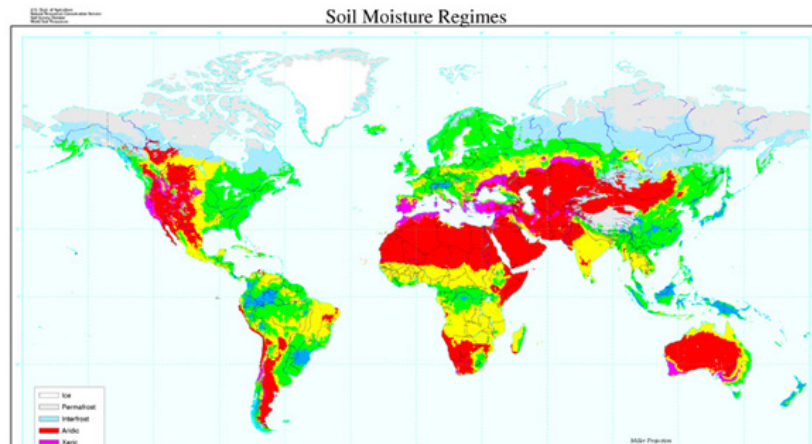


Density & Porosity Increase with  
Depth









# Initial Soil Moisture From LSM and Satellites

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